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Effects of a sustained-release multi-trace element ruminal bolus on sex ratio, reproductive traits and lambs growth in synchronized Afshari ewes

Eslam Abdollahi[1], Hamid Kohram[2,3*], Mohammad Hossein Shahir[4], Mohammad Hossein Nemati[4]

[1] PhD Student of Aniaml Physiology, Department of Animal Science, College of Agriculture, Shiraz University, Shiraz, Iran
[2]Department of Animal Science, College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran
[3]Depertment of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Chamran University, Ahvaz, Iran
[4] Department of Animal Science, Faculty of Agriculture, University of Zanjan, Zanjan, Iran

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Abstract

The objective of the present study was to investigate the effects of a sustained-release multi-trace element ruminal bolus on sex ratio**,** the reproductive performance and lambs growth of Afshari ewes. Eighty Afshari cycling ewes during breeding season were used in the trial. The animals were synchronized using CIDR for 14 days and assigned into 4 groups including: group 1 (n=20) received a single Ferrobloc bolus four weeks prior to CIDR insertion following 400 IU eCG on CIDR removal, group 2 (n=20) received two boluses four weeks prior to CIDR insertion following 400 IU eCG on CIDR removal, group 3 (n=20) received only 400 IU eCG on CIDR removal and group 4 (n=20; control) received no bolus and no eCG. Growth traits were analyzed using the mixed procedure of SAS. Number of observations (lambing rate, litter size, barren rate and the male / female lamb rate) in different groups was compared using the *Chi-Square* test. Results showed that ruminal bolus can play an indirect role in skewing sex ratio toward male offsprings. Given 1 or 2 sustained-release multi-trace element ruminal boluses four weeks before synchronization programme using eCG, causes the pregnancy of all ewes. Of the four treatments tested, the 2 boluses+eCG showed superiority on reproductive performancein terms of lambing rate (150%) and litter size (150%) in Iranian Afshari ewes during breeding season. Also, bolus supplementation enhances lamb body weight at birth up to 60 days of age.

Keywords: reproductive performance; ruminal bolus; Afshari ewe

*Corresponding author: Hamid Kohram
E mail: kohram@can.ut.ac.ir
Tel: +98 261 2248082
Fax: +98 261 2246752

Introduction

Sex ratio - that is, the ratio of male to total live births is known about the factors that affect the sex ratio of animal species. The underlying mechanisms affecting sex ratio are still complex and unclear. However, so many factors such as time of artificial insemination, dietary manipulation of animals, parental age and body condition score (BSC) between lambing and conception have been suggested to affect the sex ratio (Kent, 1995; Cheryl *et al*., 2004). There have been surprisingly few controlled experiments to investigate influences of maternal nutrition on sex ratio of offspring (Cheryl *et al*., 2004). It has been reported that diet restriction during pregnancy leads to a reduction in male offsprings. In contrast, altering the diet content, particularly diets that increase the caloric intake prior to breeding, can skew the offspring sex towards males (Green *et al*., 2008). In rats, a maternal diet high in sodium and potassium but low in calcium affects the sex ratio of offspring (Bird and Contreras, 1986).

The minerals play a major role in metabolism, growth and survival of reproductive tissues but their needs may be varied during reproductive cycles and pregnancy (Hostetler *et al*., 2003; Upadhyay *et al*., 2006). Several studies (Hurely and Doane, 1989; Upadhyay *et al*., 2006) have been reported the essential effects of trace elements on the reproductive performance and fertility of ewes. It is indicated that the essential trace minerals such as copper (Cu), manganese (Mn), zinc (Zn), iron (Fe), iodine (I) and selenium (Se) are often the most key elements for normal fetal development and embryonic survival (Hostetler *et al*., 2003). Se deficiency leads to impaired fertility, abortion and retained placentain animals (Underwood and Suttle, 1999). Zn deficiencies have been reduced fertility and litter size in multiparous species (Ali *et al*., 1998). Furthermore, it is indicated that Cu is involved in steroidogenesis and prostaglandin synthesis (Hurley and Doane, 1989) and its deficiency could lead to low fertility, delayed or depressed oestrus, abortion or foetal resorption (Upadhyay *et al*., 2006).

It is demonstrated that controlled release intra-ruminal strategies, such as boluses, provide long acting trace element supplementation in biologically available forms in sheep (Moeini *et al*., 1997; Mitchell *et al*., 2007) that in turn caused improving reproductive performance (Parkins *et al*., 1994; Hemingway *et al*., 1997). Hemingway *et al*. (2001) reported that the twin birth and the pregnancy rate were increased in the ewes given a bolus containing minerals and vitamins. Sprinkle *et al*. (2006) reported that the use of copper and selenium supplementation in late gestation successfully increased liver copper, blood selenium and reproductive performance in cows. Ahola *et al*. (2004) also showed that copper, zinc, and manganese supplementation had a higher pregnancy rate than did control over a two-year period in cattle.

The experimenthas been designed to investigate the effects of mineral supplementation on eproductive performance in the synchronized ewes using CIDR insertion and eCG injection. It was hypothesized that giving minerals before synchronization programme in ewes would affect sex ratio**,** lambing rate, litter size and improve establishment and maintenance of pregnancy. Therefore, the objective of this study was to evaluate the effects of sustained-release multi-trace element ruminal bolus supplementation onsex ratio**,** the reproductive performances such as lambing rate, litter size and barren rate of ewes. Moreover, growth characteristics interms of birth weightup tosixty days of age in lambs were determined.

Materials and methods

The experiment was conducted during breeding season (October-November), at the Zanjan University farm located in Zanjan city. The site is situated at 48.31± 21°E longitude and 36.40± 13°E latitude and at an altitude of

1663 m above sea level. The mean annual temperature is 14 °C and the annual rainfall in this region ranges from 350 to 380 mm.

Animals and synchronization program: Eighty cycling multiparous fat-tailed Iranian Afshari ewes, 3-4 years old, weighing 65.2 ± 1.8 kg, body condition score 3.04±0.03 (scales 0 to 5), were used in the trial. All ewes were fed a constant diet afalfalfa hay and concentrate feed. The ingredient composition and chemical analysis of diets are shown in Table 1. The diet was formulated to be adequate in protein, energy, vitamins and minerals to secure intake of nutrients required for maintenance in accordance with the NRC (2007).Water was available ad libitum in the shed. The basic difference between treatments was mineral bolus. The animals had not previously received eCG injection and mineral supplementation. The animals were synchronized using CIDR (EAZI-BREED^{TM}, CIDR®, NewZealand), for 14 days and assigned into 4 groups including: group 1 (n=20) received a single Ferrobloc bolus (Laprovet, Town, France - a mineral mixture are presented in the bottom of Table 1)four weeks prior to CIDR insertion in rumen following intramuscular injection (i.m.) of 400 IU eCG (Pregnecol, Bioniche, NewZealand) on CIDR removal (day 0), group 2 (n=20) received two Ferrobloc boluses four weeks prior to CIDR insertion in rumen following intramuscular injection (i.m.) of 400 IU eCG on CIDR removal (day 0), group 3 (n=20) received only intramuscular injection (i.m.) of 400 IU eCG on CIDR removal (day 0) and group 4 (n=20; control) received no bolus and no intramuscular injection of eCG. The plasma mineral status of the ewes prior to treatment set out in Table 3. Evaluations of bolus matrix release rates have been made in slaughtered ewes. About half of the matrix weight is released in the first two months. Thereafter, the daily release rate reduces and each day the mean amounts eroded from two months to about six months. According to plasma concentration of mineral prior to treatment and chemical analysis of diets, ewes were not deficient in mineral in the start of the experiment (NRC 2007). Representative samples of alfalfa hay and concentrate feed were collected weekly and dried in hot air oven at 55 °C for 48 h and analyzed for chemical composition (AOAC, 2000). Vasectomized rams were used to detect estrus in all ewes. Ewes did express estrus behavior within 36 h following removal of the CIDR, then, were mated twice daily (morning and evening in a ram: ewe ratio of 1:4) with fertile rams of the same age and breed. The reproductive traits in terms of lambing rate (number of total lambs/ number of total ewes in each group × 100), litter size (number of total lambs / number of lambing ewes in each group × 100), barren rate (number of non-pregnant ewes / number of ewes in each group × 100), and the male / female lamb rate (number of male or female lambs / total number of lambs × 100) were recorded. The ewes were weighed during pregnancy (150 days) as well asthe lamb's weights were determined once in each two weeks to the age of sixty days.

Plasma and assay procedures: The blood samples were collected in vacuum tubes (Venoject®; Sterile Terumo Europe, Leuven, Belgium) from the jugular vein immediately prior to treatment and after approximately 3.5 months (70 days of pregnancy) for determination of plasma trace elements' levels. Samples were placed on ice for 5 h before being centrifuged at 2000×g for 15 min. Plasma was then transferred to acid washed storage vials and stored at −20 ◦C. Plasma mineral concentrations were measured after the samples were thawed at room temperature for 3–4 h, then were treated with Trichloroacetic acid to precipitate the protein. The samples were analyzed for Zn, Cu, Mn, Fe, Se and I using a flame atomic absorption spectrophotometer (Spectra AA20, Varian Company; Australia–Switzerland).

Statistical analysis: Profiles of the mean of plasma concentrations of trace elements (i.e. Zn, Cu, Mn, Fe, Se and I) analysed by

ANOVA using prior to treatment as a covariate using the general linear model (GLM) procedure of SAS software (SAS Institute, Cary, NC, Version 9.1). Least significant differences were used to determine statistical significance between individual group means. Number of observations (lambing rate, litter size, barren rate and the male / female lamb rate) in different groups was compared using the *Chi-Square* test. Growth trait (lamb's weight (Kg) from birth to sixty days of ages) was analyzed separately by using the mixed procedure of SAS, with the statement repeated=age, the option sub=animal. Preliminary mixed analyses were applied to identify significant sources of variation. Birth type and sex were included in the model. Mean comparison was performed by least square mean method. Significant differences among group means were tested using Duncan's new multiple range test.

Table 1. Ingredient composition and chemical analysis of concentrate diet.

Ingredients (g/kg DM)	Concentrate feed	alfalfa hay
Soybean meal	45.5	-
Crushed corn	50.0	-
Calcium carbonate	1.0	-
Vitamin A, D and E[1]	0.4	-
Mineral mixture[2]	3.0	-
Chemical Composition (g /kg DM)		
DM	946	984.9
CP	158.8	123.6
CF	134.8	351.6
OM	920.6	352.1
Ash	54.5	62.3
Ca	8.9	6.5
P	6.9	1.4
Mg	2.0	0.9
Cu (mg/Kg DM)	11.8	5.2
Zn (mg/Kg DM)	72.1	26.4
ME (MJ/ kg DM)	12.4	8.2

[1] Vitamins consists of 600000 IU of vitamin A; 200000 IU of vitamin D; 5000 IU of vitamin E per kg of DM.

[2] Mineral mixture contained 176 g of Ca; 96 g of P; 41 g of Mg; 2 g of Fe; 0.4 g of Cu; 3 g of Mn; 4 g of Zn; 0.1 g of Co; 0.2 g of I and 0.2 g of Se per kg of DM.

Mineral bolus contained 6.9% Ca, 0.711% Mg, 0.312% Na, 0.333 g Cu, 0.16 g Mn, 0.024 g I, 0.396 g Fe, 0.06 g Co, 0.036 g Zn, 0.008 g Se.

Results

Data of reproductive traits set out in Table 2. In 2 boluses+eCG group of ewes, lambing rate and litter size were 150%, which were higher ($p< 0.05$) than other groups. Percentage of non-pregnant ewes was about 15% to 20% in eCG and control groups of ewes and in 1 bolus+eCG and 2 boluses+eCG which the ewes were all pregnant. Also male lambs were higher ($p<0.05$) than female lambs in groups 2 boluses+eCG (73.3%vs 26.6%).

The sheep given two boluses had significantly higher ($p< 0.01$) plasma copper, selenium and iron concentrations. Compared with the control group, eCG + 2 boluses group had an increased iodine status (Table 3). But, plasma manganese and zinc concentrations were not significantly different.

Dams supplemented with two boluses supplementation had heavier lambs during sixty days of age compared with control. The mean of lamb's weight during sixty days of age was increased ($p<0.05$) in all lambs (Table 4). Single or twin birth had no significant effect ($p>0.05$) on birth weight of lambs (4.2±0.1 Kgvs3.6±0.2 Kg, Table 4). The mean of birth weight of male and female lambs were 4.8±0.2 Kg and 3.4±0.2 Kg, respectively ($p<0.05$). Also, male lambs had heavier weight than female lambs during sixty days of age ($p< 0.05$).

Table 2. The effect of ruminal bolus(es) on reproductive traits of Afshari ewes during pregnancy.

Reproductive traits	Groups (n= 20 ewes/group)			
	1 bolus + eCG	**2 boluses + eCG**	**eCG**	**Control**
Lambing rate (n)	125 (25/20)[ab]	150 (30/20)[a]	115 (23/20)[ab]	105 (21/20)[b]
Litter size (n)	125 (25/20)	150 (30/20)	135.2 (23/17)	131.2 (21/16)
Barren rate (n)	0 (0/20)	0 (0/20)	15 (3/20)	20 (4/20)
Female rate (n)	40.0 (10)	26.6 (8)[c]	47.8 (11)	47.6 (10)
Male rate (n)	60.0 (15)	73.3 (22)[d]	52.1 (12)	52.3 (11)

Different superscripts ([a, b]) in the same row indicate a significant difference ($P< 0.05$).
[c,d] different superscripts in the same column indicate a significant difference between male and female lambs ($P < 0.05$).

Table 3. The effect of slow-release multi-trace element ruminal bolus on trace element status Afshari ewes (pre-treatment values are included for reference) (Mean ± SEM).

Item	Pre-treatment values	Groups			
		eCG + 1 bolus	eCG + 2 boluses	eCG	Control
Cu (µg/dl)	137.1 ± 1.5	142.1 ± 1.2[b]	147.2 ± 1.3[a]	140.5 ± 1.4[b]	139.9 ± 1.5[b]
Zn (µg/dl)	103.3 ± 2.3	105.3 ± 2.6	106.2 ± 2.5	104.1 ± 2.4	104.9 ± 2.2
Fe (µg/dl)	186.9 ± 1.9	188.8 ± 1.7[b]	193.2 ± 1.5[a]	187.6 ± 1.6[b]	188.5 ± 1.8[b]
Mn(µg/dl)	113.4 ± 0.9	116.9 ± 0.5	117.2 ± 0.7	115.9 ± 0.6	116.2 ± 0.8
Se (µg/dl)	6.2 ± 0.4	8.2 ± 0.7[b]	12.9 ± 0.5[a]	6.2 ± 0.6[b]	6.9 ± 0.3[b]
I (µg/dl)	6.7 ± 0.5	10.5 ± 0.6[ab]	12.8 ± 0.4[a]	6.9 ± 0.3[b]	6.7 ± 0.2[b]

[a,b] Different superscript indicate a significant difference ($P < 0.01$) between groups.

Table 4. The effect of ruminal bolus(es), birth type and sex on weights(kg) of the lambs at birth till sixty days of age in Afshari ewes.

Item	Lamb live weight at birth till sixty days of age				
	Birth	15 days	30 days	45 days	60 days
Group (n=20)					
1 bolus + eCG (No. of lambs = 25)	4.4 ± 0.2[ab]	9.1 ± 0.6[ab]	14.1 ± 0.6[ab]	17.1 ± 0.6[ab]	20.1 ± 0.6[ab]
2 boluses + eCG (No. of lambs = 30)	4.8 ± 0.2[a]	9.5 ± 0.6[a]	15.5 ± 0.6[a]	18.5 ± 0.6[a]	21.5 ± 0.6[a]
eCG (No. of lambs = 23)	4.2 ± 0.1[ab]	8.2 ± 0.6[ab]	13.8 ± 0.6[ab]	16.8 ± 0.6[ab]	19.8 ± 0.6[ab]
Control (21) (No. of lambs = 21)	3.7 ± 0.1[b]	8.0 ± 0.7[b]	12.4 ± 0.7[b]	15.4 ± 0.7[b]	18.4 ± 0.7[b]
Lamb Sex					
Male (No. of lambs = 60)	4.8±0.2[a]	9.8±0.2[a]	14.9±0.5[a]	17.9±0.6[a]	20.2±0.7[a]
Female (No. of lambs = 39)	3.4 ±0.2[b]	8.3 ±0.2[b]	13.5 ± 0.5[b]	16.5 ± 0.6[b]	19.4±0.6[b]
Type of birth					
Single (No. of lambs = 47)	4.2±0.1	7.3±0.4	13.3±0.4	16.4±0.6	19.1±0.5
Twin (No. of lambs = 52)	3.6±0.2	6.8 ±0.3	12.6 ± 0.2	15.8 ± 0.5	18.6±0.2

Different superscripts ([a,b]) in the same column indicate a significant difference ($p < 0.05$).

Discussion

The lambing rate and litter sizein ewes given 2 boluses four weeks before CIDR insertion and treated with 400 IU eCG were significantly higher compared to the other groups. Previously, Hartley and Grant (1961), Hartley (1963), Andrews *et al*. (1968), Godwin *et al*.(1970), Kott *et al*. (1983) and Hemingway *et al*. (2001) used the minerals and/or vitamins supplementation with different forms in ewes before natural mating and reported the increase in lambing percentages. Published data investigating effects of ruminal bolus on sex ratio, reproductive traits before synchronization program and eCG treatment in ewes was not tested, as far as the authors know. The results of the present study showed that the lambing rate and litter sizeof ewes following synchronization program in the group 2 boluses+eCG ewes were 150%. MAFF(2000) reported that given the slow-release rumen-blouses Se plus I, Co alone and combined Se/I plus Co to the Scottish Blackface ewes during three weeks before the onset of mating increased the number of twin lambs and total lambs. These reports are inagreement with our results and suggest that slow-release multi-trace element ruminal boluses increase lambing rates and litter size.

Essential trace elements including copper, iodine, iron, selenium, manganese and zinc play a major role on reproductive function such as fertility in ruminants (Hostetler *et al*., 2003; Upadhyay *et al*., 2006). Scales (1974) reported a significant reduction of 12% in the proportion of barren ewes in three of four New Zealand trials, resulting from oral administration of 5 mg as sodium selenite given seventeen days before mating. Hemingway *et al*. (2001) also reported that using a sustained-release multi-trace element/ vitamin ruminal bolus, declined non-pregnant ewes given one bolus compared to control (from 14% to 6%). MAFF (2000) investigated Se, I and Co supplementations either singularly or in combination and reported that Se plus I and Co boluses alone reduced the number of barren ewes. In the present study, all ewes were pregnant in 1 bolus+eCG and 2 boluses+eCG groups of ewes. Indeed following synchronization protocol, all ewes given bolus and eCG injection were pregnant during breeding season.

The underlying mechanisms that prompt, sex ratio are still complex and unclear. Maternal nutrition is one of factors can affect the sex ratio. In ewes, altering the diet content prior to breeding might provide a means of manipulating the sex ratio, e.g., females in better body condition would produce more male than female progeny (Kent, 1995). It is suggested that under favourable environmental and maternal conditions giving birth to male infants would be favoured and the probability of delivering a female infant would increase under unfavourable conditions (Cheryl *et al*., 2004), which could roughly been supported by our results. In the present study, male lambs were higher than female lambs in ewes fed two boluses. In this study all ewes were given a moderate energy and protein diet. Increasing the maternal proteins and energy intake and their metabolism would be as important determinants of sex ratio in male offsprings (Cagnacci *et al*., 2004). In a study, 75% of the calves born to a high energy group were male, while a low energy group produced only 46% males (Cheryl *et al*., 2004). It reported that food restriction ofewes results in a skewing of offspring sex ratio, which has been attributed to a decrease in uterine glycerylphosphorylcholine diesterase activity (Mitra and Chowdhury, 1989).

The sheep that received two boluses had significantly increased copper, iodine, iron and selenium status at the second blood sampling (70 days after treatment). But plasma zinc concentrations were not significantly higher than others. When only zinc supplementation is given, a decrease in copper status could occur due to the fact that there is an interaction between copper and zinc. However, the negative effect of zinc supplementation on copper status decreases by giving slow release multitrace bolus (Kendall *et al*., 2001). The

exact mechanism for that is not understood. However, it could be due to combination of zinc, cobalt or selenium (Kendall *et al*., 2001). In current study plasma Mn concentration did not differ between groups. More supplementation of selenium and iodine to safety margin (difference between normal requirement and toxic dose) has resulted in an increased immune response in sheep and vigour and survival of lambs (MAFF, 2000; Kendall *et al*., 2001). According to reports of producer company and local trials, recovery of ferrobloc boluses last for six months. The release period of ferrobloc boluses (approximately six months) means that essential trace element such as copper, iodine, iron and selenium can be supplied to sheep when mineral supplementation is required (McDowell, 1992).

It is reported that the number of lambs born alive for control and selenium-vitamin E treated ewes were 1.61 and 1.81, respectively, ($p < 0.1$) (Segerson *et al*., 1986). In our study mineral bolus had a positive effect on birth weight, daily weight gain and body weight up to 60 days of age as compared to control. It seems that the higher growth rate in lambs suckled by supplemented ewes is due to increase in milk production (Idris *et al*., 2010). Øvernes (1993) reported that adequate measures of minerals should be taken to ewes to ensure that animals receive an optimal amount of mineral supplementation. Mineral supplementation for example iodine, selenium, copper, when plasma mineral concentration was within the reference value, appeared to contribute to a healthier udder status of ewes (Underwood and Suttle, 1999; kendall *et al*., 2001). Practically, mineral boluses enhance the status of minerals such as iodine, selenium, copper and zinc and may indirectly improve animal performance (Underwood and Suttle, 1999; Hemingway *et al*., 2001), possibly by strengthening the immunity of the animals (MAFF, 2000; Kendall *et al*., 2001).

There are conflicting results about effects of type of birth (litter size) and sex on birth weight of lambs (Atta and El Khidir, 2004; Yilmaz *et al*., 2007). In the present study, singles were not heavier than twins at birth up totwo months of age. Adequate feed intake during pregnancy improved offspring's birth weight, survival, mammary gland development and milk production (Mellor and Murray, 1985). Many authors confirmed that sex affects the live weight and growth intensity of lambs (Said *et al*., 2000; Momani Shaker *et al*., 2002). In the current study, the mean of birth weight of male and female lambs were also different. On the contrary, Mehta *et al*. (1995) and Idris *et al*. (2010) showed that the differences between males and females birth weight were not significant.

In conclusion, the underlying mechanisms affecting sex ratio are likely to be complex and are not well understood. Our studies on ewes indicate that possibly mineral supplementations (boluses) enhance maternal protein- energy intake and their metabolism which can play anindirect role in skewing sex ratio toward maleoffsprings. All ewesgiven1 or 2 sustained-release multi-trace element ruminal boluses four weeks before synchronization program using eCG got pregnant. Of the four treatments tested, the 2 boluses+eCG group showed superiority on reproductive performance in terms of lambing rate and litter sizein Iranian Afshari ewes. Also, our findings emphasize the positive effects of the boluses supplementation on body condition of ewes in late pregnancy and lamb body weight at birth up to 60 days of age. This study designed with limited numbers of animals, soit is recommended that this experiment could conduct with more replicates per each group to express reproductive traits more comprehensively. However, further strategic and applied research is needed to understand more completely the underlying metabolic mechanisms and responses of sheep to sustained-release multi-trace element ruminal boluses. The results suggests that using the protocol to two bolus plus eCG could increase the overall flock reproductive performance, as well as offspring vigor and survival.

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اثرات بلوس شکمبه ای با ویژگی آزادسازی آهسته روی نسبت جنسیت، صفات تولیدمثلی و رشد بره ها در میش های افشاری همزمان سازی شده

اسلام عبدالهی[1]، حمید کهرام[2و3]، محمدحسین شهیر[4]، محمدحسین نعمتی[4]

[1]دانشجوی مقطع دکتری تخصصی فیزیولوژی دام دانشکده کشاورزی دانشگاه شیراز، شیراز، ایران
[2]گروه علوم دامی، پردیس کشاورزی و منابع طبیعی دانشگاه تهران، کرج، ایران
[3]گروه علوم درمانگاهی دانشکده دامپزشکی دانشگاه شهید چمران اهواز، اهواز، ایران
[4]گروه علوم دامی، دانشکده کشاورزی دانشگاه زنجان، زنجان، ایران

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چکیده

هدف از مطالعه حاضر بررسی اثرات بلوس شکمبه ای با ویژگی آزادسازی آهسته، روی نسبت جنسیت، عملکرد تولیدمثلی و رشد بره های حاصل از میش های افشاری می باشد. 80 رأس میش های افشاری در فصل تولیدمثلی به طور تصادفی انتخاب شده و به مدت 14 روز بوسیله سیدر همزمان شده و به 4 گروه (n=20) تقسیم شدند: گروه های 1 و 2 به ترتیب یک و دو قرص فروبلوک چهار هفته قبل از سیدرگذاری دریافت نموده و به هر دو گروه 400 واحد بین المللیeCG در زمان برداشت سیدر به صورت درون ماهیچه ای تزریق شد. گروه 3 فقط 400 واحد بین المللیeCG در زمان برداشت سیدر دریافت نمودند و گروه 4 به عنوان گروه شاهد در نظر گرفته شده که نه قرص فروبلوک دریافت کرده و نه eCG. صفت رشدی با استفاده از SAS و با رویه میکس آنالیز شد. تعداد مشاهدات (درصد بره زایی، چندقلوزایی، درصد قصر و نسبت جنسیت) با استفاده از آزمون کای اسکور آنالیز شد. نتایج نشان داد که بلوس شکمبه ای به طور غیرمستقیم باعث افزایش درصد جنسیت نر می شود. خوراندن بلوس شکمبه ای در چهار هفته قبل از همزمان سازی فحلی باعث آبستنی همه میش ها می شود. گروه دوبلوس+ eCG در مقایسه با سایر گروه ها تاثیر زیادی روی عملکرد تولید مثلی نظیر درصد بره زایی (150%) و چندقلوزایی(150%) در فصل تولیدمثلی دارد همچنین بلوس شکمبه ای باعث بهبود افزایش وزن بره ها از زمان تولد تا سن 60 روزگی می شود.

واژگان کلیدی: عملکرد تولیدمثلی، بلوس شکمبه ای، میش های افشاری